



**Climate-Hydrology Forecasts and Risk-Based Reservoir  
Management in Northern California:  
Design and Initial Tests of the Real-Time INFORM System**

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*CEC/CEPA Climate Change Research Conf., Sacramento, 15 Sep. 2006*





## WHAT IS THE INFORM SYSTEM?

- A REAL-TIME HYDROLOGIC FORECAST – DECISION SUPPORT SYSTEM
- FIVE LARGEST CALIFORNIA RESERVOIRS and DOWNSTREAM.
- TIME SCALES - HOURS-TO-SEASONS.
- UNCERTAINTY EXPLICITLY TREATED IN ALL COMPONENTS.
- DECISION SUPPORT FOR SUPPLY, FLOOD CONTROL, HYDRO-POWER, FLOW, PLANNING.
- MULTI-AGENCY SUPPORT AND USE.





## THE INFORM SYSTEM

PRECIPITATION AND TEMPERATURE FORECASTS

RAIN-SNOW-SNOWMELT – DOWNSCALING MODELS

RIVERS - HYDROLOGIC MODELS

RESERVOIRS

DECISION SUPPORT  
RELEASES and  
DOWNSTREAM SYSTEM





## PURPOSE OF INFORM

INCREASE EFFICIENCY OF WATER USE

USING CLIMATE, HYDROLOGIC AND DECISION SCIENCE





## SPONSORS-COLLABORATORS

### Sponsors:

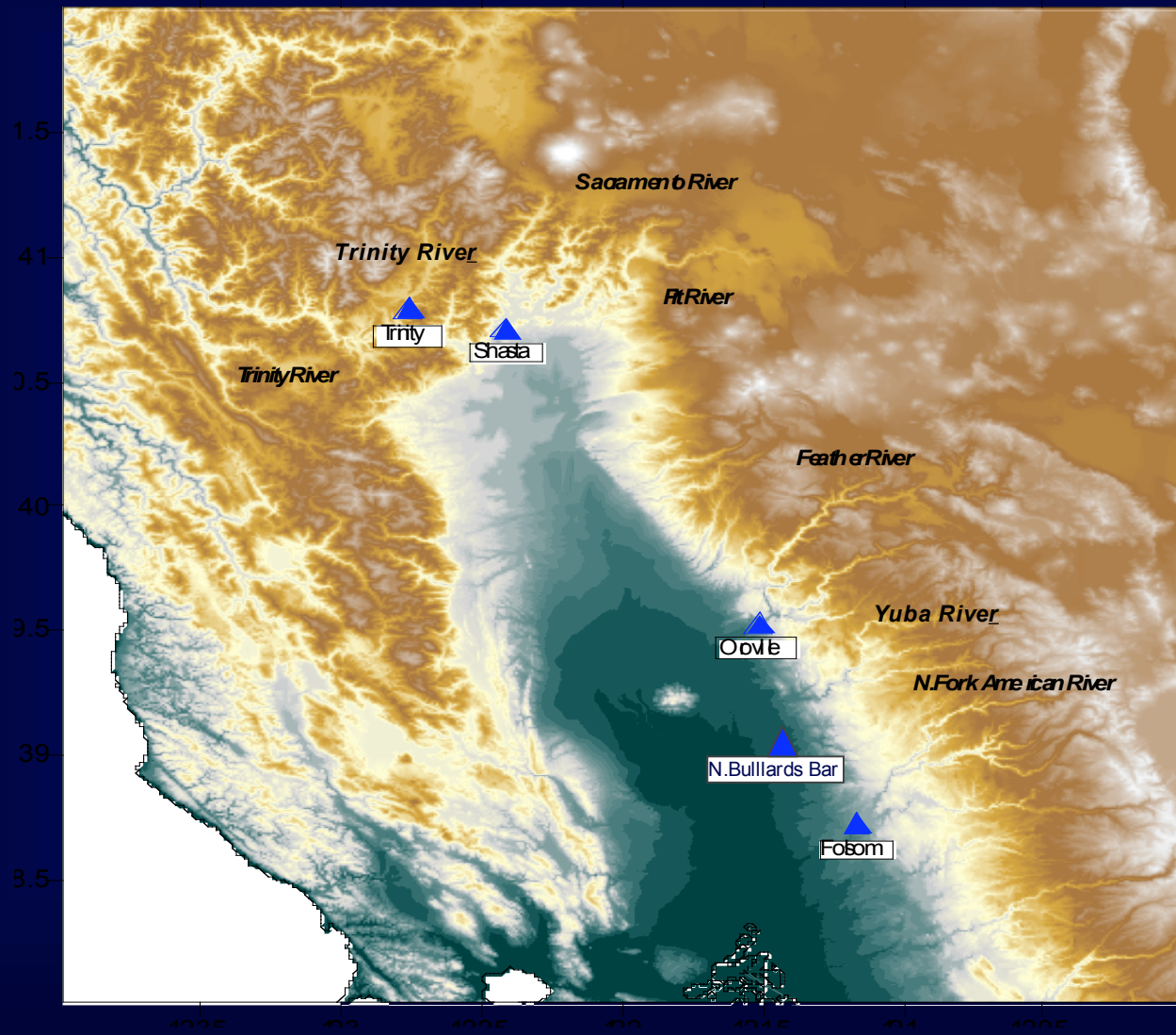
CALFED Bay Delta Authority  
California Energy Commission  
National Oceanic and Atmospheric Administration

### Collaborators:

California Department of Water Resources  
California-Nevada River Forecast Center  
Sacramento Area Flood Control Agency  
U.S. Army Corps of Engineers  
U.S. Bureau of Reclamation



## APPLICATION AREA



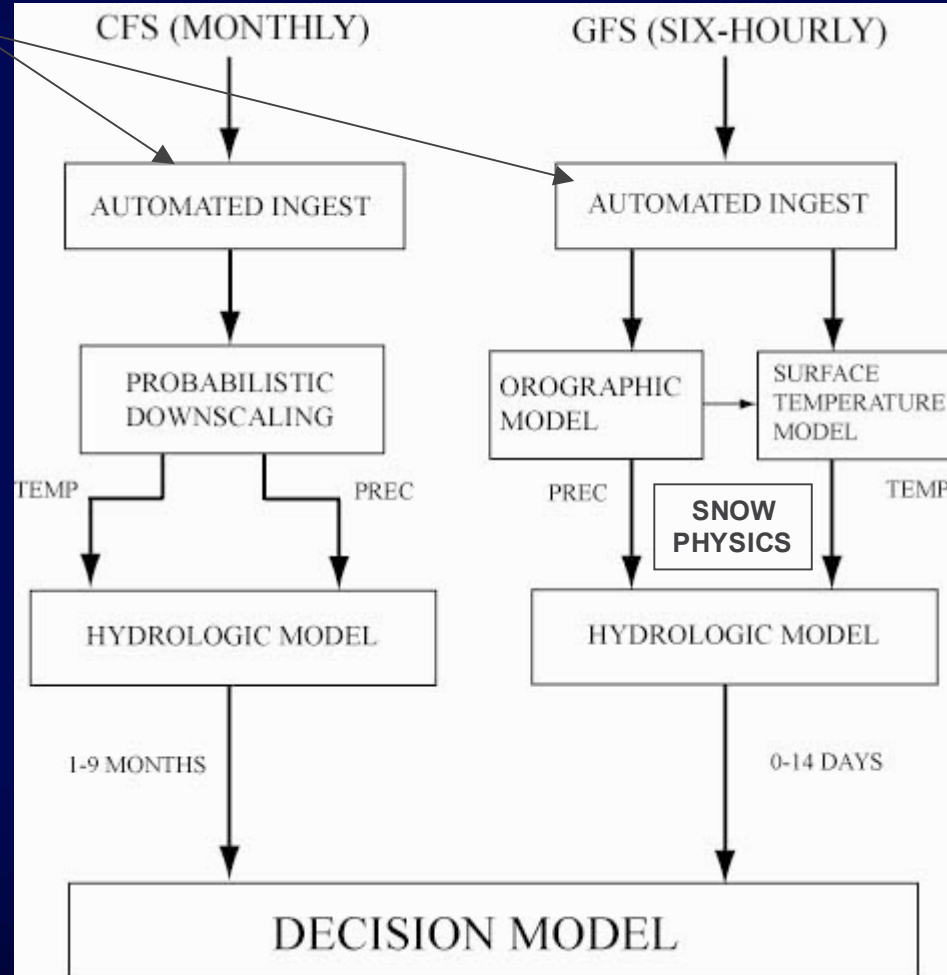


# MET. / CLIMATE / HYDRO. SYSTEM DESIGN

ENSEMBLES

SEASONAL

DAYS / WEEKS



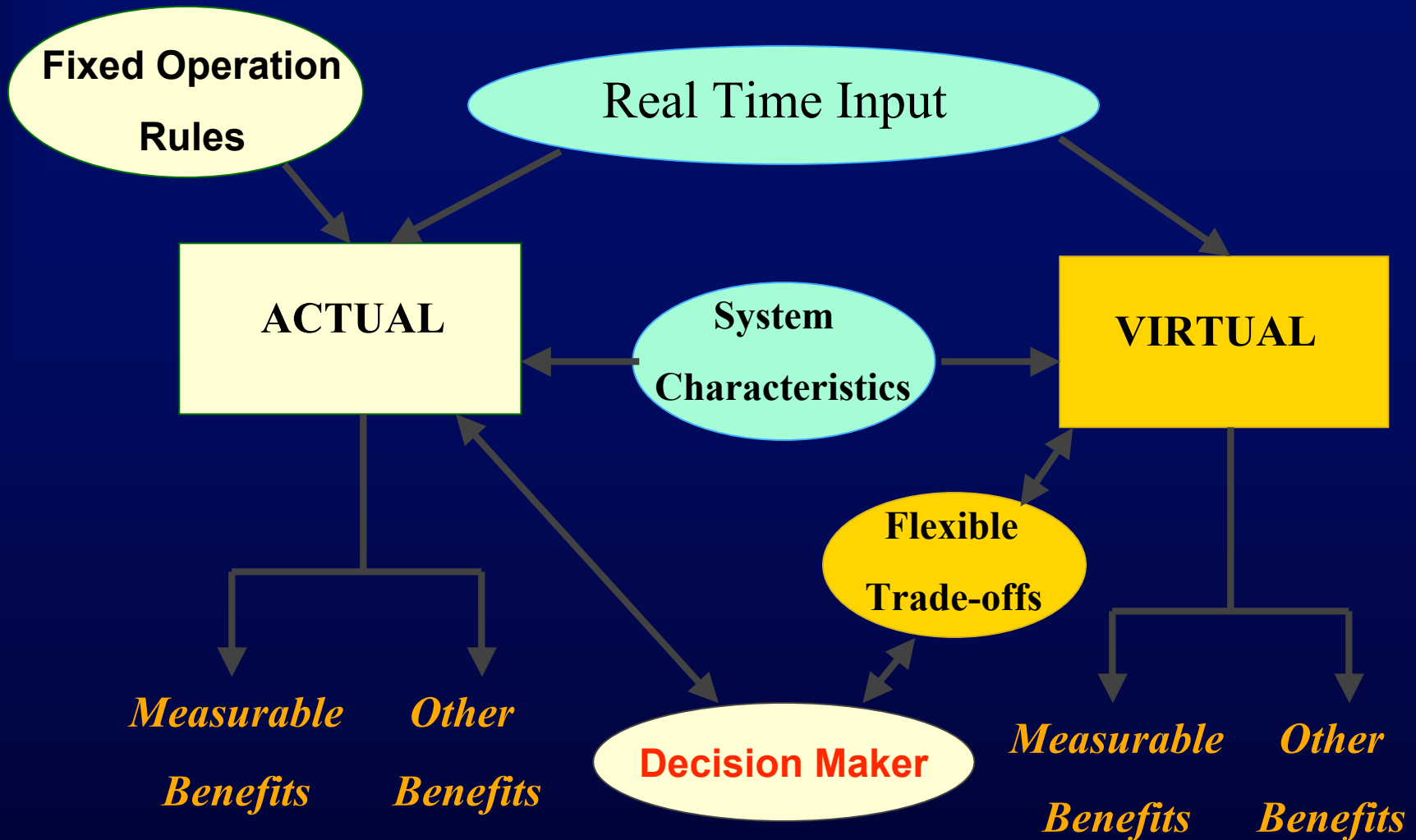
## First Three Years of INFORM Complete

- INFORM system developed and components tested with historical data.
- Initial demonstration with real time data from 2005-06 wet season in California.





## Demonstration Concept – Testing and Verification



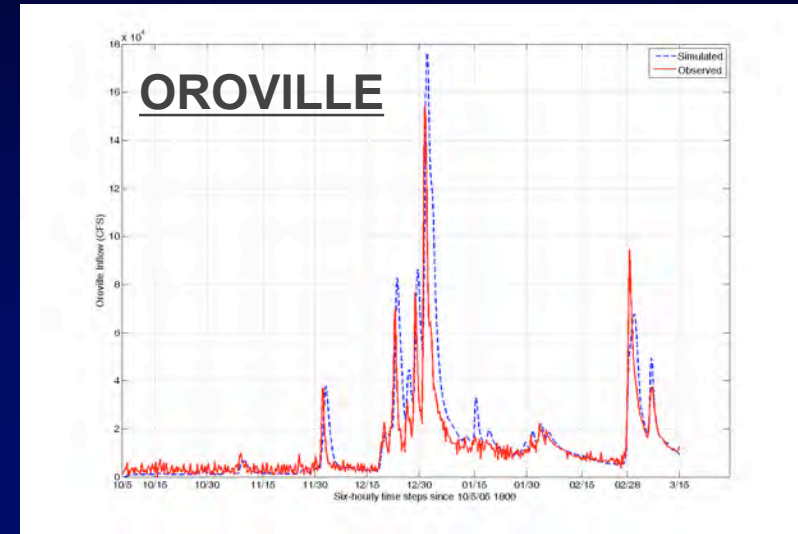
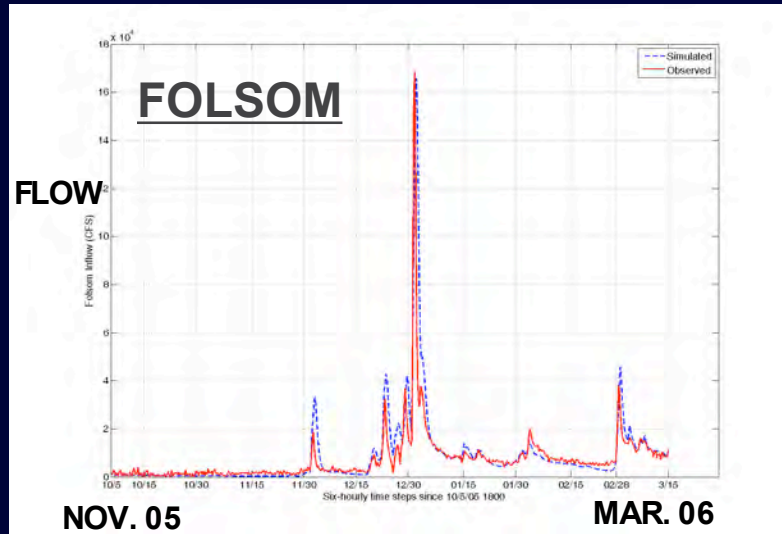


## WET SEASON 2005-2006 ASSESSMENTS

### Simulations with:

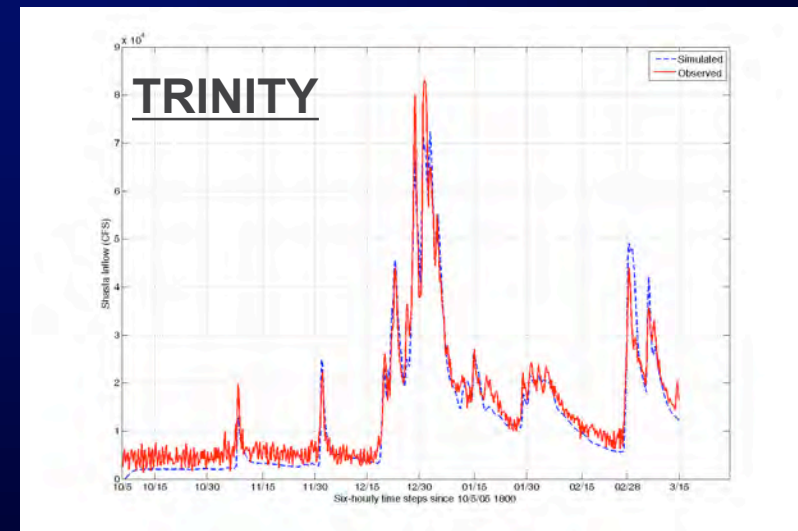
- Observed Precipitation and Temperature
- Precipitation forecasts
- Temperature forecasts (critical for snowmelt)
- Inflow forecasts





**HYDROLOGICAL MODELS  
WORK WELL  
OBSERVED PRECIP. & TEMP.**

--- SIM  
— OBS





# ENSEMBLE FORECAST VALIDATION

--- SIM. (ENSEMBLE RANGE)

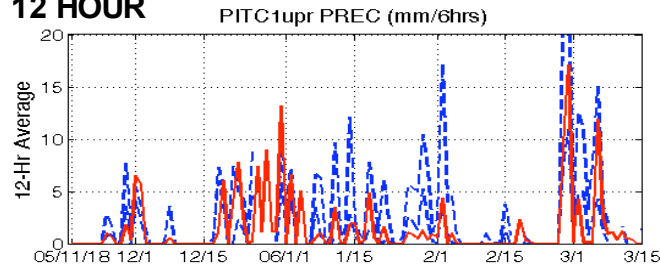
— OBS

PRECIPITATION

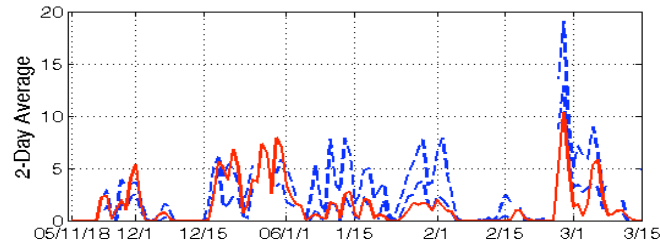
PITT RIVER

TEMPERATURE

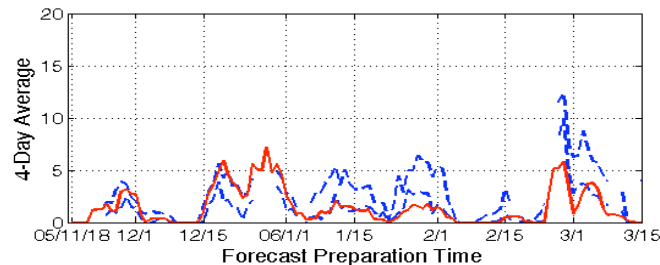
12 HOUR



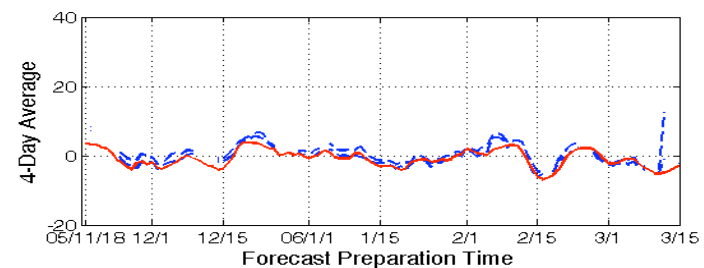
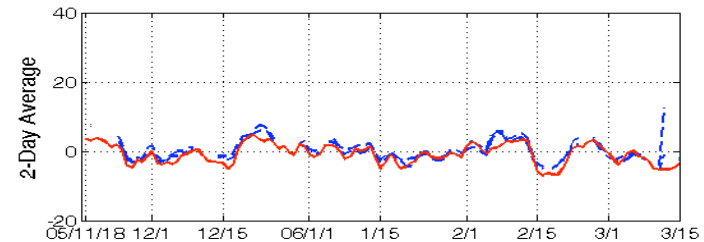
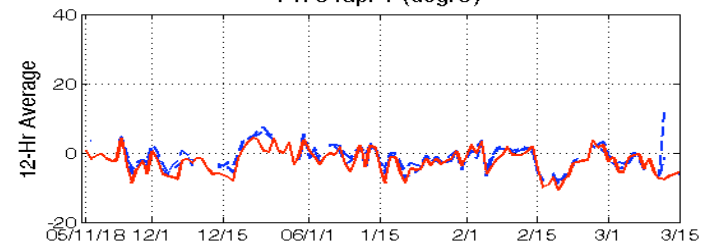
48 HOUR



96 HOUR

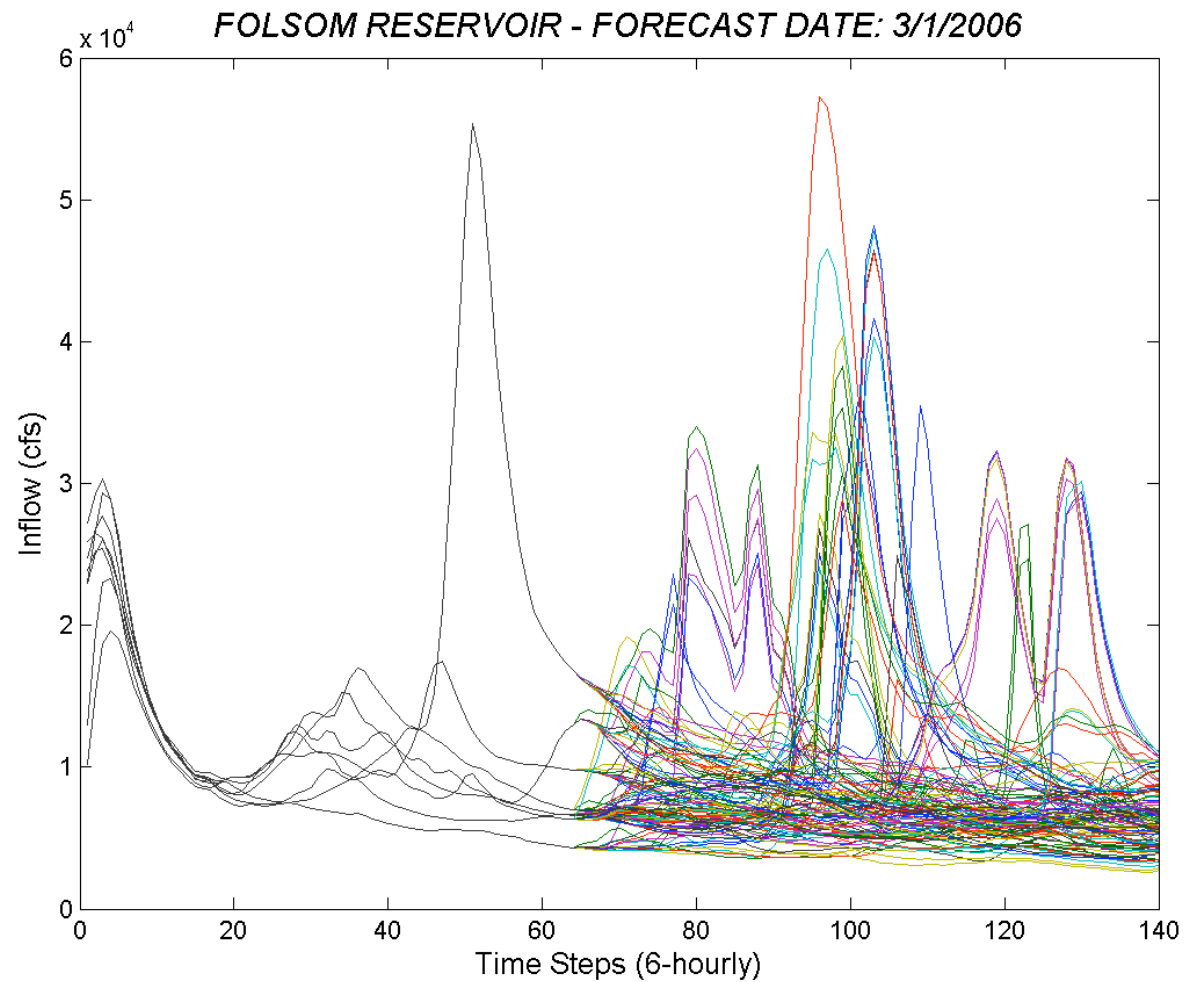


PITC1upr T (degrC)





## Blending of Synoptic and Climate Time Scale Forecasts







## INFORM - DECISION COMPONENT

water supply – flood control - hydro-power – downstream flow

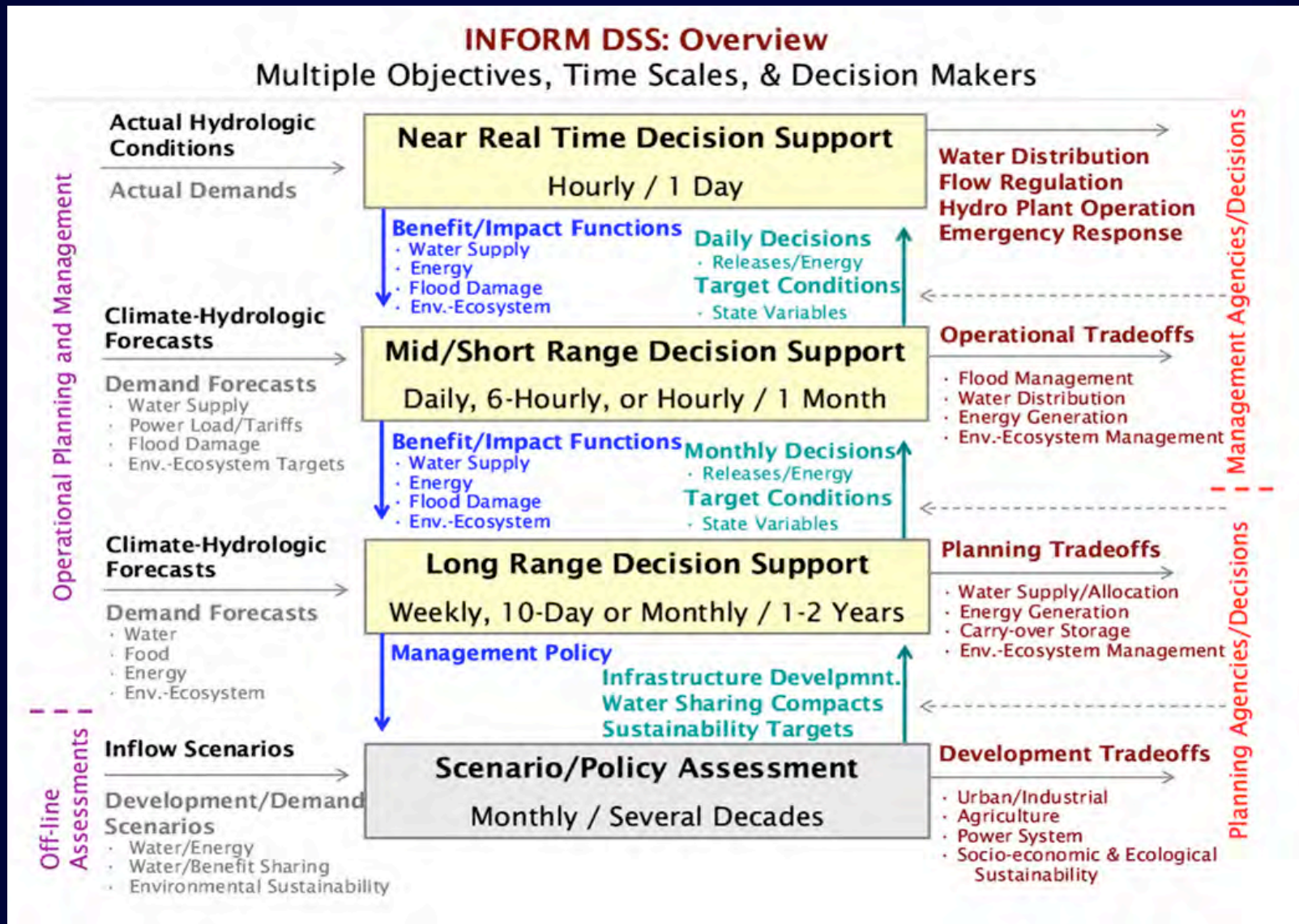




## INFORM DECISION COMPONENT



# INFORM DECISION COMPONENT





## INFORM DECISION COMPONENT

### DOWNSTREAM PORTION

Central Valley Operations – State Water Project

- SIMULATION OF DETAIL IS MANDATORY
- MUST BE CONSISTENT WITH OTHER OPERATIONAL TOOLS
- COMPARE WITH CALSIM – DWR / BuRec SWP–CVP Simulation Model
- EXCELLENT AGREEMENT
- EACH SYSTEM HAS PARTICULAR ADVANTAGES -  
CALSIM CAN DISAGGREGATE INFORM LONG-RANGE POLICIES

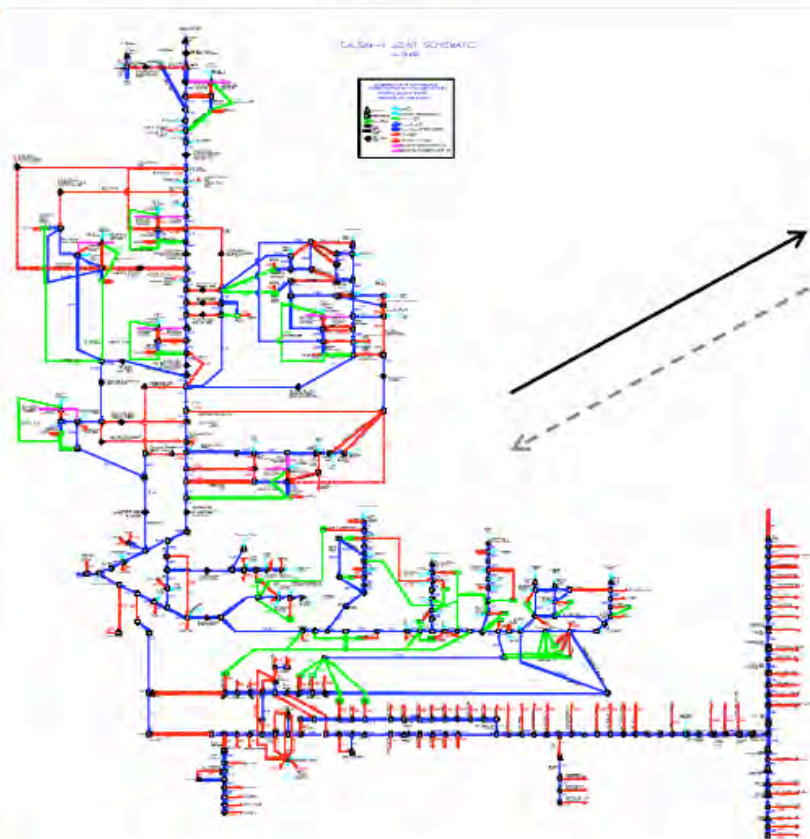


# INFORM-CALCIM Model Comparison

## Is INFORM DSS Consistent with CALSIM?



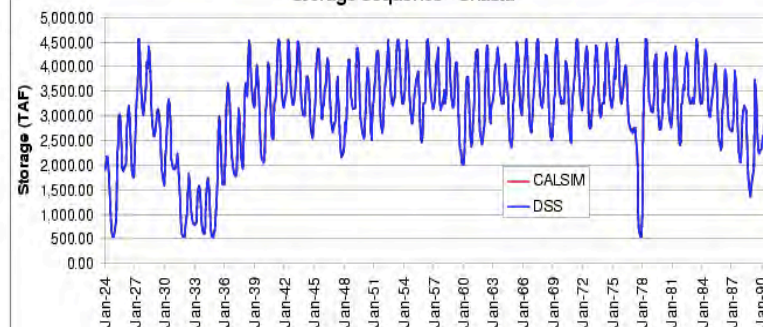
### CALCIM



### INFORM



Storage Sequence - Shasta







## INFORM DECISION COMPONENT

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## Spring 2006 Case Study



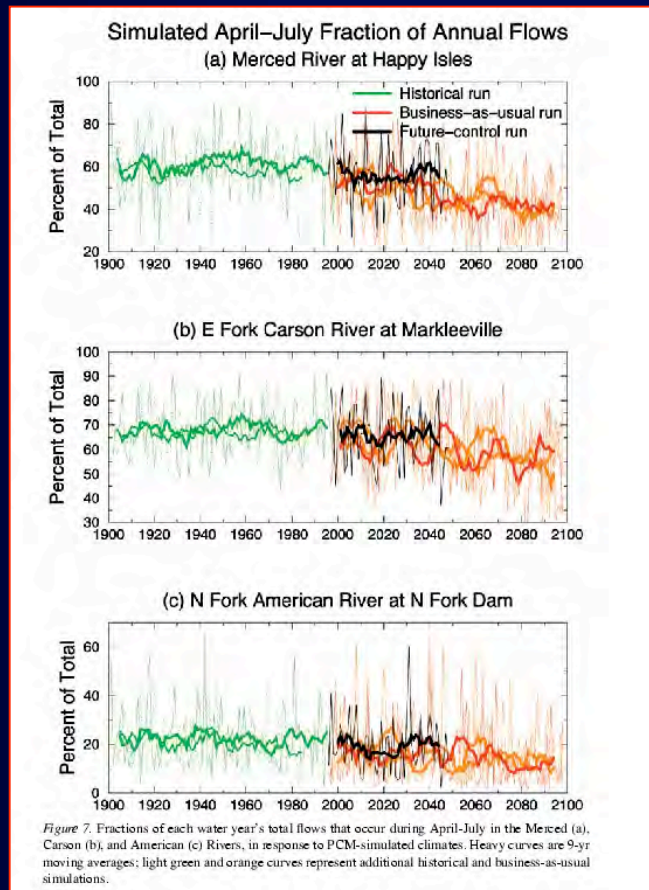
### RESULTS

- Forecasts correctly anticipated wet season;
- Planning model indicated that water allocation could be increased by 10% of base demand without compromising other water uses;
- INFORM DSS can generate a suite of other tradeoffs of potential interest to the management authorities;
- The system is ready to be applied operationally and evaluated with actual hydrologic forecasts and demand data by the stakeholder agencies over the next 2-3 seasons.





## ADAPTATION TO FUTURE HYDROLOGICAL CLIMATE



From Dettinger et al. 2004



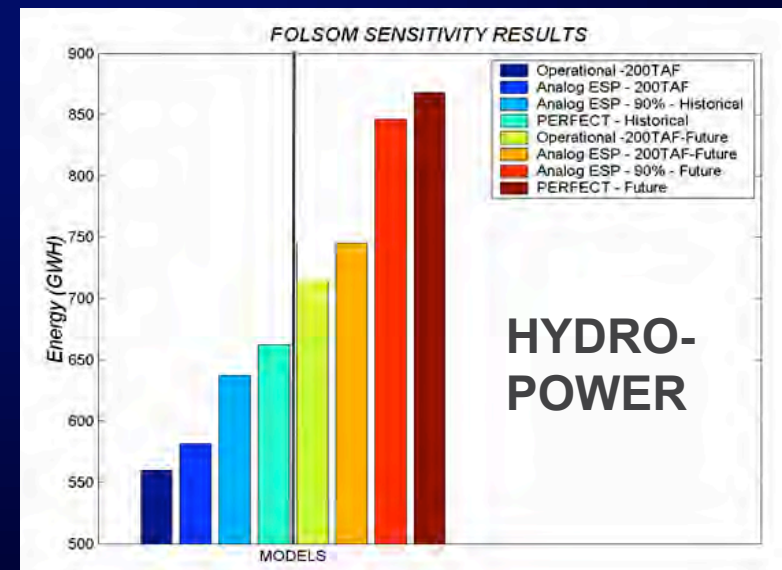
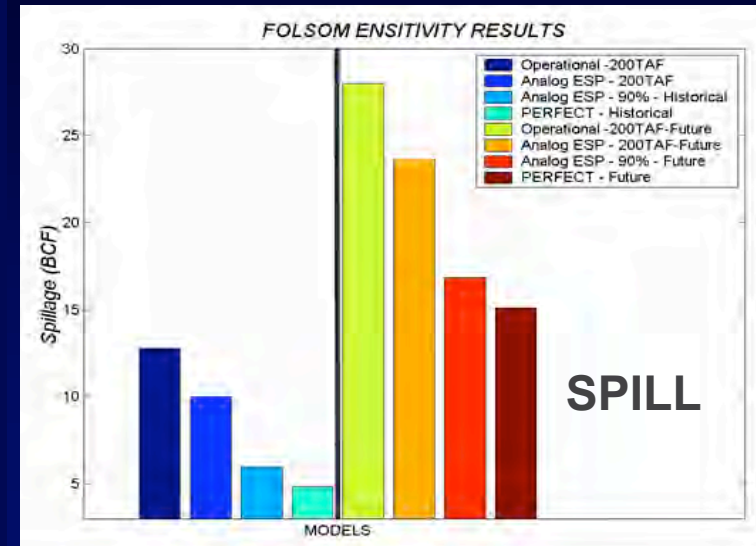
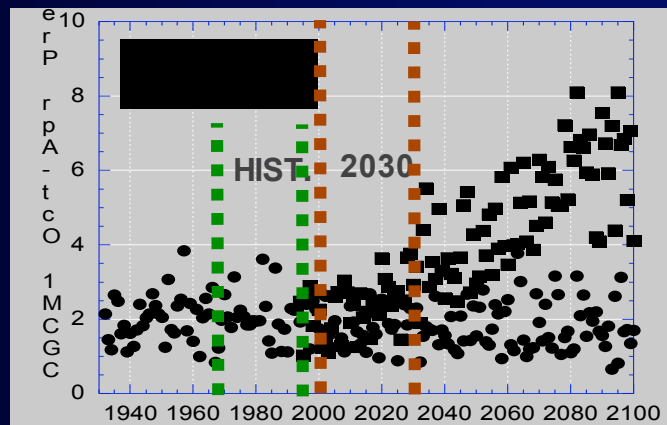
## INFORM CLIMATE CHANGE EXPERIMENTS FOLSOM RESERVOIR:

- 1964-1993 – HISTORICAL
- 2001-2030 – CGCM1 (1% yr<sup>-1</sup>)
- ANALOG FLOW TRACES
- NO CHANGES IN SWE
- NO CHANGES RUNOFF TIMING

A) GOOD FORECASTS HELP

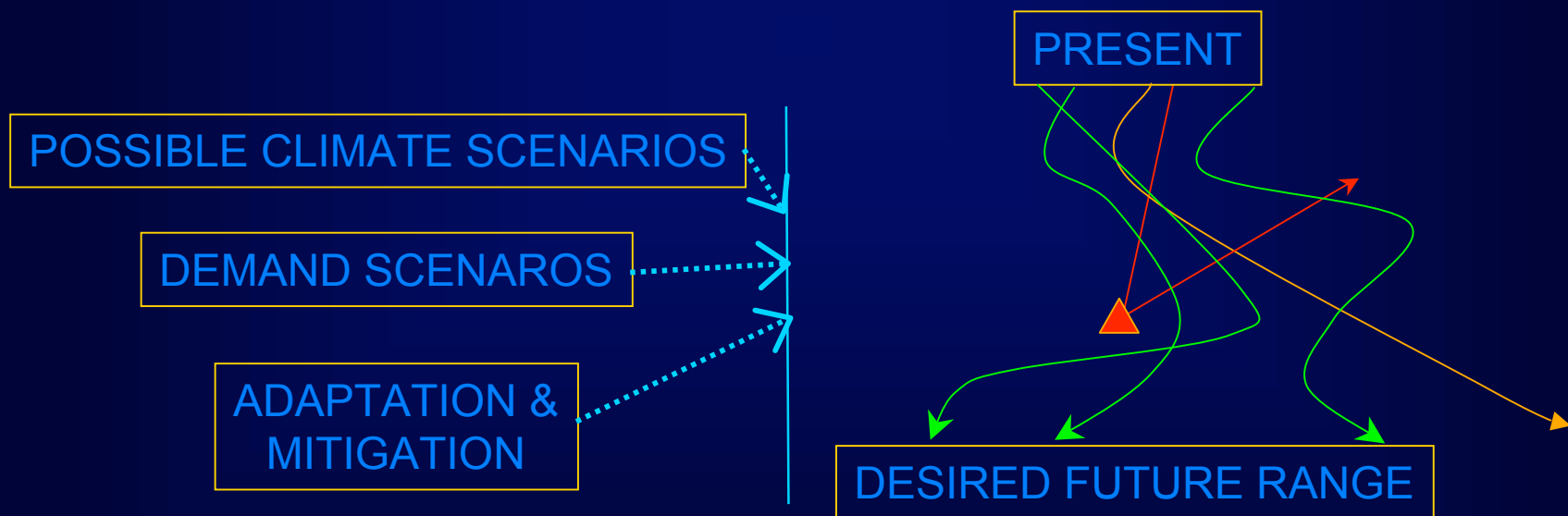
B) KNOWN UNCERTAINTY IS ESSENTIAL.

C) BEST EFFICIENCY IS ACHIEVED BY  
CHANGING PROCEDURES WITH A and B.



## INFORM COMPONENTS SIMULATION, PLANNING, MITIGATION AND ADAPTATION

- OUTLINE FEASIBLE WATER USE FUTURES
- DEFINE **FEASIBLE** AND **NON-FEASIBLE** PATHS
- IDENTIFY / AVOID **CRISIS POINTS**
- TEST ADAPTATION AND MITIGATION STRATEGIES
- WHAT-IF SCENARIOS





## SUMMARY

- 1) INFORM: A HYDROLOGICAL FORECAST – DECISION SUPPORT SYSTEM.
- 2) UNCERTAINTY INCLUDED THROUGHOUT.
- 3) 5 LARGEST N. CALIF. RESERVIORS – DOWNSTREAM TO BAY DELTA.
- 4) INCORPORATES MANY KEY DETAILS FOR CVO PLANNING.
- 5) FIRST OPERATIONAL TESTS DURING WINTER 2005-2006.
- 6) FURTHER REFINEMENTS, AGENCY TRIALS TO CONTINUE.
- 7) COMPLETE TOOL FOR CLIMATE CHANGE PLANNING.

